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Description of the world's first troglobitic Pselaphini: *Geopselaphus bullonorum* sp. nov. from southern Spain (Coleoptera, Staphylinidae, Pselaphinae)

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Abstract

A new Pselaphinae rove beetle species belonging to the genus *Geopselaphus* Jeannel, 1956, *G. bullonorum* **sp. nov.**, from a cave in south Spain is described and diagnosed. Important morphological features of the new species are listed and photographed. The new species shows a significant troglomorphy, such as the reduction of the eyes (only three unpigmented ommatidia) and an extraordinary general elongation of the body (especially the head) and appendages (antennae, maxillary palps and legs). Being the first troglomorphic Pselaphini known worldwide.

Keywords

Cave-dwelling species, new species, Pselaphitae, troglomorphism

Introduction

Geopselaphus was established by Jeannel (1956) as a subgenus of *Pselaphus* Herbst, 1792. Subsequently, it was revised by Besuchet (1961a), who raised it to the genus level, and shortly after Besuchet (1961b) included it in a key of the Iberian Pselaphini. Subsequent contributions to the Iberian fauna were the description of new species, nomenclatural changes and new records (Besuchet 1969; Löbl 1998; Pérez and Castro 2011).

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The genus *Geopselaphus* currently includes 24 known species (Schülke and Smetana 2015) and it is distributed through the mountain areas of eastern and southern Iberia, northern Morocco and Algeria as well as, the Balearic Islands (Mallorca) (Besuchet 1961a, 1969). There are very few data on its biology and habitat, but specimens are usually found sifting moss or forest litter and under stones deeply buried in the soil (Español 1935; Besuchet 1961a). They can also be found in the endogean environment, using the washing soil technique combined with Berlese funnels (unpublished observations). Recently, one species (*Geopselaphus franzi* Besuchet, 1961) has been recorded from the deep subterranean environment, although most likely it is an incidental finding (Pérez and Castro 2011; Assing 2013).

During several biospeleological explorations in the Cueva de la Pileta (Benaoján, Málaga, Spain) a new species of *Geopselaphus* was discovered, which is described here. The new species has several characters typical of those living in subterranean habitats, such as reduced eyes (only three unpigmented ommatidia, likely not functional) and a general elongation of the body (especially the head) and appendages (antennae, maxillary palps and legs).

Currently, approximately 170 species of Pselaphinae are known around the world that are associated with caves and that present different degrees of the adaptation to the deep subterranean environment (Poggi et al. 1998; Yin et al. 2015). The majority of troglobitic species are concentrated in the supertribes Goniaceritae and Batrisitae, where troglomorphy is relatively common, but this adaptive characteristic is extremely rare in the supertribe Pselaphitae, which currently has only one known troglobitic representative, a tyrine balkanic species *Decumarellus sarbui* Poggi, 1994, with a marked troglomorphy that is endemic to the Peştera de la Movile cave in Romania (Poggi et al 1998; Hlaváč et al. 2008; Hlaváč et al. 2017). It is also worth mentioning that a representative of the tribe Tmesiphorini from a cave in Nepal that has been described, *Pseudophanias spinitarsis* Yin, Coulon & Bekchiev, 2015, a non-troglomorphic species with well-developed eyes and hind wings, revealing only a modest adaptation to the underground environment (Yin et al. 2015). Our finding is therefore very surprising, because as it is the second troglobitic representative of the supertribe Pselaphitae and the first known member of the tribe Pselaphini with a marked troglomorphy at a global level.

A further surprise is that the species has been found in Cueva de la Pileta, a cave discovered in 1905 (Bullón Giménez 2005), and one of the most important locations for biospeleology in the southern Iberia (Pérez et al. 2013). The cave was visited for the first time for scientific purposes by the archaeologist H. Breuil in 1912, who collected the first samples of subterranean arthropods (Jeannel and Racovitza 1914, 1918, 1929; Pérez 2014), among them two new species: *Trechus breuili* Jeannel, 1913 (Coleoptera, Carabidae) and *Iberoniscus breuili* Vandel, 1952 (Crustacea, Isopoda). Later, although far apart in time, the visits for biospeleological purposes continued from 1934 until into the 1980s, with some of the most prominent biospeleologists of the time taking part in successive sampling, e.g., C. Bolívar, H. Coiffait, J. Mateu, and A. Vandel, (Pérez et al. 2013), despite all these visits to the cave, this new species of

Geopselaphus was not detected until 2013. Currently, the cave continues to be studied and in recent years a series of interesting publications have been produced (Carabajal et al. 2012; Pérez et al. 2013; Pérez and Aguilera 2014; Miralles and Pérez 2015; Garcia et al. 2020).

Materials and methods

This study is based on the examination of 3 specimens of *Geopselaphus* collected in the Cueva de la Pileta in south Spain. Type material of *Geopselaphus bullonorum* is deposited in the following collections:

CCH Carles Hernando private collection, Badalona, Catalonia, Spain;
MCNB Museu de Ciències Naturals, Barcelona, Catalonia, Spain.

Dissections were made using standard techniques. Genitalia were dissected from the abdomens of specimens previously softened in boiling water for 5 minutes. Contents of the abdomen were cleared using boiling 10% KOH for 2–3 minutes to remove internal tissues, and then washed in hot water before examination. After examination, genitalia were mounted on plastic transparent cards in dimethyl hydantoin formaldehyde resin (DMHF) and pinned beneath the specimen. Specimens were studied with a Leica M125 C stereomicroscope. Habitus images were taken using a Canon EOS 50D digital camera with attached Canon MP-E 65 mm f/2.8 1–5 macro lens. Male genitalia were photographed using a Canon EOS 50D digital camera attached to a Zeiss Axiostar plus compound microscope. Serial images were stacked with Helicon Focus software.

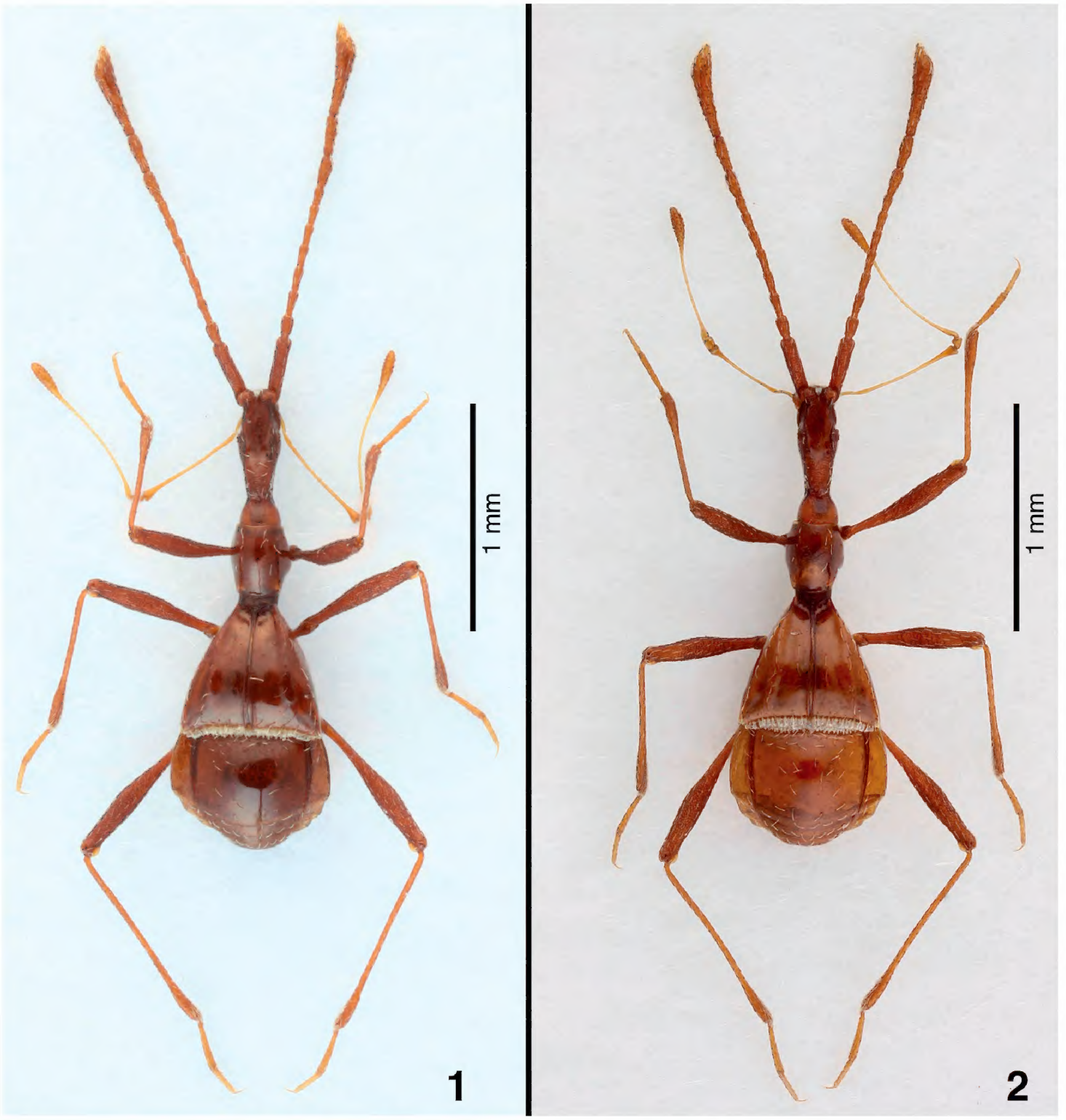
Results

Family Staphylinidae Latreille, 1802
Subfamily Pselaphinae Latreille, 1802
Genus *Geopselaphus* Jeannel, 1956

***Geopselaphus bullonorum* Hernando & Castro, sp. nov.**
http://zoobank.org/E23CEBBD-3EED-4372-8606-D7F958A5E447
Figs 1–10

Type locality. Cueva de la Pileta (La Pileta Cave), 36°41'28.51"N, 5°16'11.66"W, 724 m a.s.l, Sierra de Grazalema, Benaoján, Málaga, Andalusia, Spain.

Type material. ***Holotype.*** ♂: Spain: "ESP. Málaga, Benaoján / Cueva de la Pileta, 04-26-2013 / 36°41'28.51"N; 5°16'11.66"W, 724 m a.s.l. / F. Fadrique leg", (MCNB).



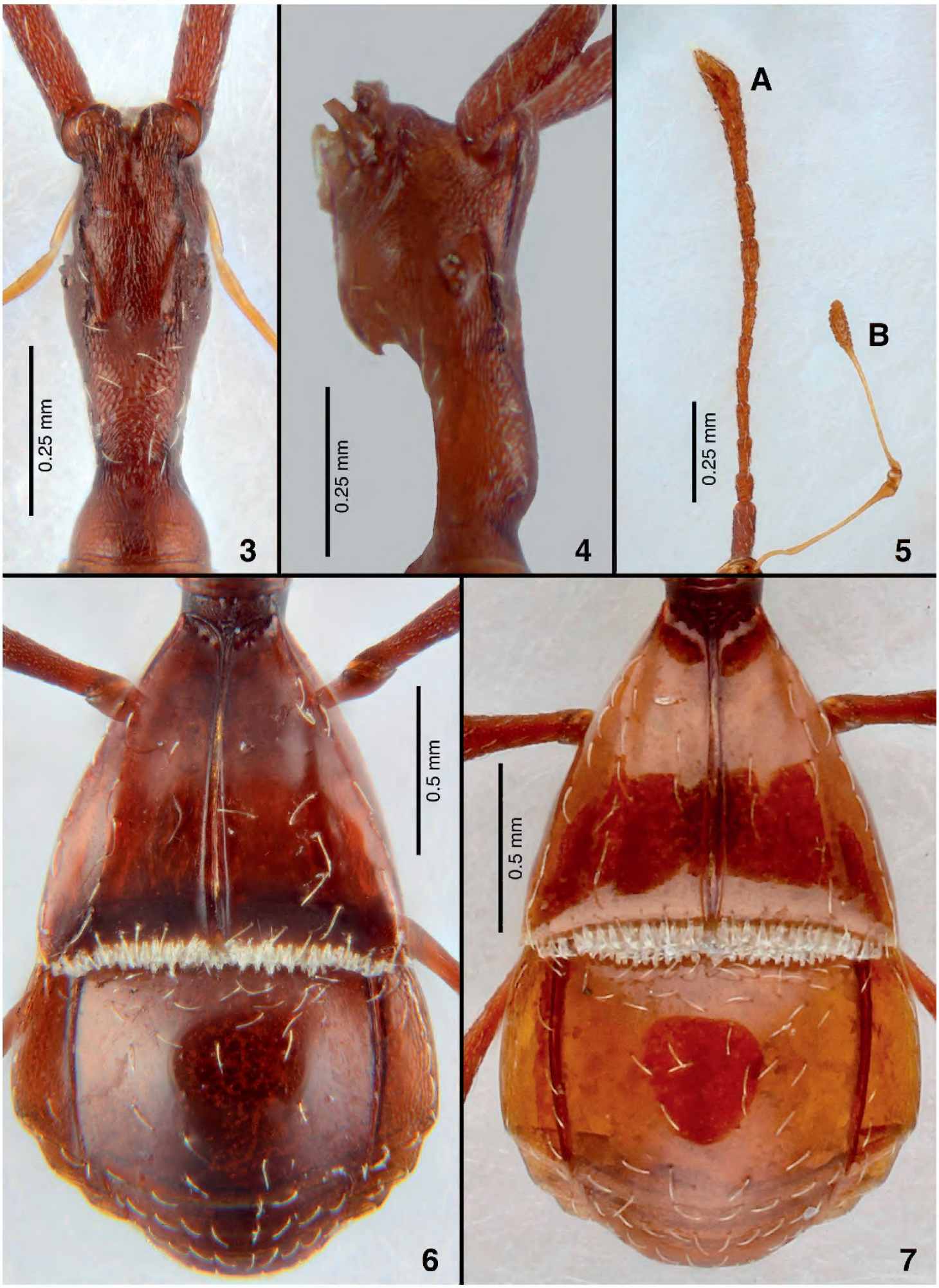
Figures 1–2. *Geopselaphus bullonorum* Hernando & Castro, sp. nov. Habitus in dorsal view **1** male **2** female.

***Paratypes*:** 1 ♀: same data as holotype, (MCNB); 1 ♀: "ESP. Málaga, Benaoján / Cueva de la Pileta, 06-08-2015 / Sierra de Grazalema-Ronda / 36°41'28.51"N; 5°16'11.66"W, 724 m a.s.l. / T. Pérez leg.", (CCH).

Etymology. We dedicate this new species to the Bullón family, historical owners of the Cueva de La Pileta.

Description of holotype. Habitus as in Fig. 1. Body length: 2.13 mm. Apterous and microphtalmic, with only three omatidia (probably non-functional eyes). Entirely pale brown with lighter maxillary palpi and tarses. Body (specially the head) and appendages (antennae, maxillary palpi and legs) extraordinary elongated and slender. Pubescence of the dorsal surface consist of short suberect white setae on head, pronotum, elytra and abdomen, pubescence on the ventral surface consists of very dense clusters

of tomentose setae on the head, mesoventrite and first visible sternite, and short, suberect, white setae on the metaventrite and sternites, other suberect shorter setae on antennae and legs.



Figures 3–7. *Geopselaphus bullonorum* Hernando & Castro, sp. nov. head **3** dorsal view **4** lateral view. Head appendages **5A** antennae **5B** maxilar palpi. Elytra and abdomen in dorsal view 6 male 7 female.

***Head*:** (Figs 3, 4) total length (0.64 mm), maximum width (0.17 mm). Extraordinarily elongate, 3.5 times longer than wide, clearly narrower than pronotum. Frons broadly grooved and distally bilobed, narrow and shallow longitudinal groove starts between both lobes, which extends back to level of eyes. Dorsolateral part with two longitudinal and parallel carinae, clearly higher in supra-ocular area and attenuated backwards, with tomentose fossae very small. Surface entirely microreticulated, dorsal pubescence composed of few short, white, semi-erect setae arranged in pair of lateral longitudinal series. In lateral view (Fig. 4), dorsal part practically flat in its anterior part, barely gibbous and slightly narrowed at posterior part. Gular protuberance projecting backward and hook-shaped (Fig. 4). Tomentose pubescence of ventral part, short and sparse, extending from gular protuberance to basal narrowing (Figs 8, 9). Eyes reduced, with only three unpigmented ommatidia, likely not functional (Fig. 3). Antennae (Fig. 5) extraordinarily long (1.57 mm) and slender, exceeding the posterior margin of elytra when bent backwards, scape cylindrical and parallel-sided, 3.2 times longer (0.28 mm) than wide (0.04 mm), pedicel cylindrical and subparallel-sided, 1.3 times longer (0.08 mm) than wide (0.04 mm), antennomeres 3–7 cylindrical, equal in length and longer (0.11 mm) than wide (0.04 mm); antennomere 8 cylindrical, with equal width, but shorter (0.06 mm) than previous five; antennomeres 9–10 cylindrical, both very similar in length and shape, wider and twice as long as previous six antennomeres; terminal antennomere very long (0.37 mm) and club-shaped, slightly asymmetrical at apex and with equal length as three previous antennomeres together. Maxillary palps extraordinarily long (1.57 mm) and slender (Fig. 5), palpomere 1 filiform, slightly curved; palpomere 2 very long (0.48 mm), filiform over practically its entire length and abruptly widened at its apical end; palpomere 3 very short and conical; palpomere 4 very long (0.73 mm), slightly arched, filiform throughout practically its entire length, progressively thickening at apex, which is club-shaped and with surface of thickened part completely covered with granules and very fine and erect pubescence.

***Pronotum*:** Longer (0.32 mm) than wide (0.24 mm) with subparallel sides, with the anterior and posterior margins straight, the latter finely bordered, surface smooth and shiny and with two dorsal longitudinal series of setae, each consisting of 4–5 white and semi-erect setae.

***Elytra*:** Strongly narrowed at base, practically as long (0.6 mm) as wide (0.62 mm); each elytron with three basal foveae; humeral carinae entire and well-marked, each elytron with raised, entire and well-apparent discal carinae (Figs 6, 7), with entire sutural stria; surface smooth and shiny, the pubescence on each elytron composed of three series of white and semi-erect setae, two located along the two carinae and a third very short series on the discal surface, with the posterior margins of each elytron decorated by transverse series of semi-erect setae widely spaced and on same edge with dense fringe of tomentose setae (Fig. 6).

***Ventral part*:** Mesoventrite with two very dense clusters of tomentose setae (Fig. 8), metaventrite convex, smooth and shiny and with some widely scattered semi-erect setae (Fig. 8).

***Abdomen*:** With tergite IV (first visible tergite) very large, clearly wider (0.71 mm) than long (0.51 mm), shorter than the elytra and clearly wider than these, with a smooth

and shiny surface and series of semi-erect setae along entire posterior margin. Sternite III (first visible sternite) with a broad transverse fringe of tomentose hairs that occupies entire basal part and with a long tuft of erect setae in central part of posterior margin (Fig. 8).

***Male genitalia*:** Median lobe strongly acuminate at apex (Figs 10, 11) and in lateral view with the apex curved inwards (Fig. 12), internal sac with two fascicles of small spines (Fig. 11) and apical structure formed by modified spines of squamiform shape.

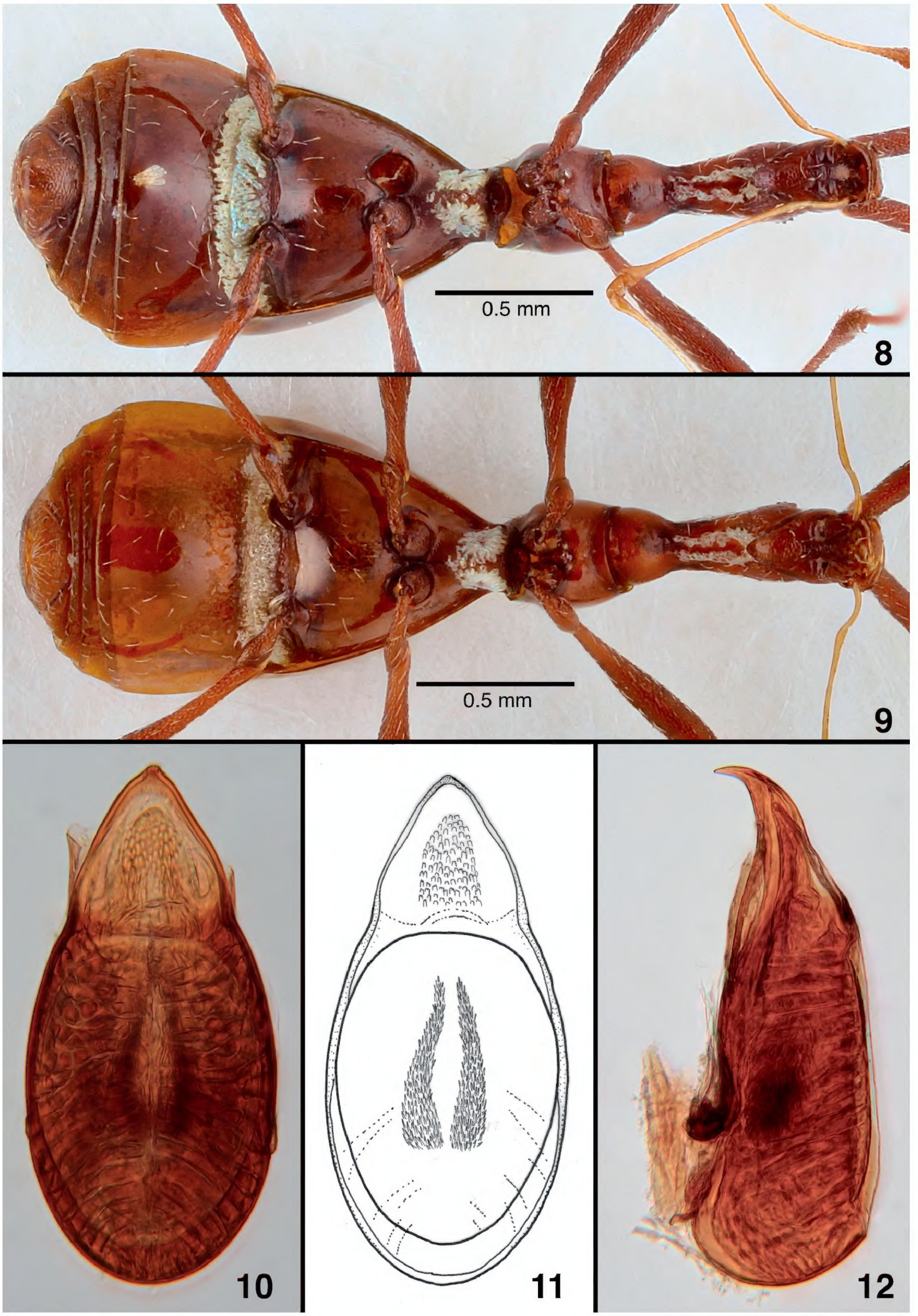
Female: General appearance similar to male (Fig. 2), but with posterior margin of the elytra with the fringe of tomentose setae broadest and more developed (Fig. 7), tergite IV clearly longer (0.55 mm), practically as long as length of elytra (Fig. 7), sternite III longer, without tuft of erect setae and rugulose at the base (Fig. 9).

Comparative notes. The new species is well distinguished from the rest of the known species of the genus by its marked troglomorphism, such as the reduction of the eyes (only three unpigmented ommatidia) and an extraordinary general elongation of the body (especially of the head) and appendages (antennae, maxillary palps and legs). It is also characterised by the small size of the tomentose foveae on the head, which are large in the rest of the known species, the elytra have a complete dorsal carina (Figs 6, 7), which is absent or slightly elevated in the rest of the known species of the genus, and the aedeagus is quite different (Figs 10–12). It has also been compared with its geographical neighbour *Geopselaphus longulus* Besuchet, 1961, an endogean species showing some elongation of the head and palps, but always in comparison with the other endogean species and without any comparison with the new species.

Based on the aedeagus, *Geopselaphus bullonorum* seems to be close to *Geopselaphus sencieri* (Coquerel, 1858), distributed in Algeria, Morocco and the extreme south of the Iberian Peninsula (Jeannel 1956), both species have an acuminate median lobe, and the internal sac is very similar, consisting of two fascicles of spines (see Besuchet 1961).

Geographic distribution. So far, only known from the typical locality.

Habitat. The Cueva de la Pileta has a total length of 2.406 m and a maximum slope of 102 m. All the specimens were captured wandering on walls in the sector called "La Gran Sima", which is in one of the deepest parts of the cave, approximately 400 m from the cave entrance. This cave harbours a rich community of terrestrial subterranean arthropods, 32 species have been recorded so far (Pérez et al. 2013; Pérez and Aguilera 2014; Miralles and Pérez 2015), of which 12 are exclusively troglobitic. Six of them have a relatively wide distribution: *Iberoniscus breuili* Vandel, 1952, *Trichoniscus gordoni* Vandel, 1955 (Isopoda); *Lithobius motasi* Matic, 1967 (Lithobiomorphae); *Tegenaria herculea* Fage, 1931, *Troglohyphantes furcifer* (Simon, 1884) (Araneae) and *Laemostemus lederi* (Schaufuss, 1865), *Trechus breuili* Jeannel, 1913, *Speonemadus bolivari* (Jeannel, 1922) (Coleoptera); two species have a very restricted distribution and are only known from the Cueva de la Pileta and from some other caves in the same geographic area: *Cryptops longicornis* Ribaut, 1915 (Scolopendromorpha) and *Dysdera bicornis* Fage, 1931 (Araneae) and finally, with the new species describe here, four endemic species are known from Cueva de la Pileta: *Baeticoniscus bulloni* Garcia, Miralles-Núñez & Pérez, 2020 (Isopoda); *Glomeris* (*Stenopleuromeris*) *albida* Mauriès & Vicente, 1977 (Glomerida); *Occidenchthonius bullonorum* (Caravajal, García Carrillo & Rodríguez Fernández, 2012) (Pseudoscorpiones) and *Geopselaphus bullonorum* sp. nov.



Figures 8–12. *Geopselaphus bullonorum* Hernando & Castro, sp. nov. Ventral part **8** male **9** female. Aedeagus **10–11** dorsal vision **12** lateral vision.

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